
## Faculty of Mechanical and Manufacturing Engineering Technology

# OPTIMIZATION OF LASER JET MACHINING PARAMETER ON COMPOSITE USING TAGUCHI

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**Bachelor of Manufacturing Engineering Technology (Process and Technology)**

**2020**

# OPTIMIZATION OF LASER JET MACHINING PARAMETER ON COMPOSITE USING TAGUCHI

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**A thesis is submitted**
**in fulfilment of the requirement for the Bachelor of Manufacturing Engineering Technology (Process and Technology)**

**Faculty of Mechanical and Manufacturing Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2020**

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **OPTIMIZATION OF LASER JET MACHINING PARAMETER ON COMPOSITE USING TAGUCHI**

SESI PENGAJIAN: **2019/2020 Semester 1**

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SupervisorName : TS.MOHAMMAD KHALID BIN WAHID

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**DEDICATION**

.

*This dissertations gratefully dedicated to*

*my beloved father, Sahimi bin Othman and my mother, Jamiah binti Osman.*

*my respected person late grandmother, Maimunah Binti Ahmad*

*my siblings for their motivation and advice. Mohammad Jasmin, Noor Adlina,*

*Nor Hikmah, Mohammad Faiz Safwan and my younger sister Nur Fatin Ruqaiyah.*

*To my supervisor, TS. Mohammad Khalid bin Wahid.*

*Thank you so much for all your support and guidance during completed this thesis.*

## ABSTRACT

Thesis reports are experiments related to the effects of parameters on laser machines using the taguchi method for raw materials are composites. This is because the composites have many advantages caused by high redundancy. Laser machining has been used for this study in composite product cutting methods based on the advantages this method can achieve. By conventional methods, the main limitation is the weakening of the surface. The proposed deduction as a method of improvement and design of the experiment (DoE) is used to approach this study. Furthermore,weaknesses have been found using conventional methods. An alternative way to use a laser machine is therefore recommended to solve the problems faced by manual cuts to achieve the goals stated in this study. This study consists of laser power, cutting speed, assisted gas pressure and focal distance. Quality reduction such as finished surfaces to determine laser cutting parameters. Parameters to get a good surface. The laser machine is a technology that uses lasers to cut material. For overall of this study the parameter when using laser machining that approximately 1500rpm is the optimum speed parameter which is nice. The nozzle gap result is 0.9 to 1.5. The closer the material nozzle, the easier it can be cut. It also depends on a high or low flow of gas as it will expand the cutting and cause burn mark. In general, there must be more information about running the machine and the process of laser cutting in order to challenge the student while doing the task. Next, takes too long to repeat the process parameters one by one to determine the optimal parameters.

## ABSTRAK

Laporan tesis adalah eksperimen yang berkaitan dengan kesan parameter pada mesin laser menggunakan kaedah taguchi untuk bahan mentah adalah komposit. Ini kerana komposit mempunyai banyak kelebihan yang disebabkan oleh redundansi yang tinggi. Pemesinan laser telah digunakan untuk kajian ini dalam kaedah pemotongan produk komposit berdasarkan kelebihan kaedah ini dapat dicapai. Dengan kaedah konvensional, batasan utama adalah melemahkan permukaan. Potongan yang dicadangkan sebagai kaedah penambahbaikan dan reka bentuk percubaan (DoE) digunakan untuk mendekati kajian ini. Tambahan pula, kelemahan telah dijumpai menggunakan kaedah konvensional. Oleh itu, cara alternatif untuk menggunakan mesin laser adalah disyorkan untuk menyelesaikan masalah yang dihadapi oleh pemotongan manual untuk mencapai matlamat yang dinyatakan dalam kajian ini. Kajian ini terdiri daripada kuasa laser, kelajuan pemotongan, tekanan gas yang dibantu dan jarak fokus. Pengurangan kualiti seperti permukaan selesai untuk menentukan parameter pemotongan laser. Parameter untuk mendapatkan permukaan yang baik. Mesin laser adalah teknologi yang menggunakan laser untuk memotong bahan.Untuk keseluruhan kajian ini parameter apabila menggunakan pemesinan laser yang kira-kira 1500rpm adalah parameter kelajuan optimum yang bagus. Hasil jurang muncung ialah 0.9 hingga 1.5. Lebih dekat dengan muncung bahan, lebih mudah ia boleh dipotong. Ia juga bergantung kepada aliran gas yang tinggi atau rendah kerana ia akan mengembangkan pemotongan dan menyebabkan tanda terbakar. Umumnya, terdapat lebih banyak maklumat tentang cara menjalankan mesin dan proses pemotongan laser untuk mencabar pelajar ketika melakukan tugas. Seterusnya, mengambil masa terlalu lama untuk mengulangi parameter proses satu demi satu untuk menentukan parameter yang optimum.

## ACKNOWLEDGEMENT

Assalamualaikum, firstly I would like to grateful to Allah, praise to Allah the lord of the universe and may blessing and peace of Allah be upon his messenger Muhammad S.A.W. for enabling me to complete technical report on time and fulfilled the requirements of the subject Project Sarjana Muda

I would like to express my beloved supervisor, TS.Mohammad Khalid Bin Wahid, lecturer of FTKMP, Universiti Teknikal Malaysia Melaka for his kind supervision,advice and guidance as well as exposing me with meaningful throughout the study.

Last but not least, I would like appreciation is extended to my beloved parents, Sahimi bin Othman and Jamiah binti Osman who supported and motivated myself to complete this thesis. Not forgotten, to my entire friends and classmate for giving any ideas and opinion during this research. Therefore, my speacial gratitide and thanks to assistant engineers, Mr.Basri bin Bidin, Mr.Azizul Ikwan bin Mohd and Zuraini bin Zachairiah for giving me such attention and time

Finally, I would like to thank everybody who was important to this thesis, as well involved directly or indirectly towards the complication of this thesis.

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| PMC | Polymer Matrix Composite |
| CMC | Ceramic Matrix Composite |
| CFRP | Carbon-Fiber Reinforced Polymer |
| PVC | Polyvinyl Chloride |
| UPR | Unsaturated polyester resins |
| CNC | Computer numerical control |
| MEKP | Methyl ethyl ketone peroxide |
| RSM | Response surface methodology |

## LIST OF SYMBOLS

| | |
|---|---|
| mm | milimeter |
| % | Percentage |
| $0^2$ | Oxygen |
| μm | micromilimeter |
| $N^2$ | Nitrogen |
| G | Gram |
| Kg | Kilogram |
| Hz | hertz |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

In this paper would like to move a following problem, which of these laser. Laser can be defined the energy source an acronym for light amplification by stimulated emission radiation that focuses optical energy on the surface of the work piece. Laser also categorized under high beam machining. Laser are very bright and can be seen in the bright condition. There also can cause damage the important body part is eyes if point directly to eyes. The highly concentrated laser beam, high-density energy melts and evaporates portions workpiece in a controlled manner and also laser considerations include the reflectivity and thermal conductivity of the material. This process also, which does not allow a vacuum, is used to machine a variety of metallic and nonmetallic materials.

According to Avanish Kumar Dubey *et al,* (2007), the laser beam can be generally used for cutting, drilling, marking, welding, sintering and heat treatment. The laser is also used for turning and friction operations, but laser beams are used extensively is mainly in cutting of metallic and non-metallic sheets.

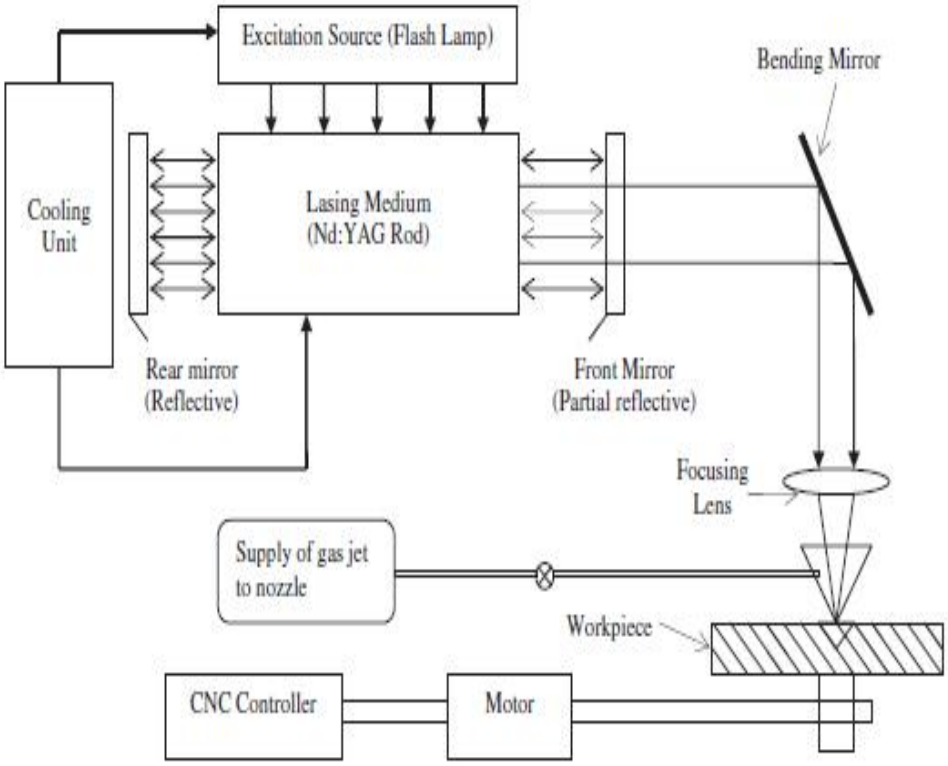


**Figure 1.1** : Schematic of Nd:YAG laser beam cutting system.

Based from Figure 1.1, the drawing of schematic of Nd:YAG laser beam cutting system. Laser beam cutting has many different methods of cutting using laser. There is vaporization, melting and blowing. Melt blow and burn, cracking thermal stress,cold cutting and burning stabilized laser cutting. The vaporization of the focused beam heats the material surface. In melt and blow uses high-pressure gas to blow molten material from the cutting area. However, the concept of laser are add energy to make electrons “jump” to higher energy orbit, electron relaxes and moves to equilibrium at ground state energy level and emits a photon in this process key laser component. For pulsed Nd:YAG laser systems (also to CO2 systems), laser cutting quality is governed by many parameters some of them are related to the laser equipment for example maximum laser power, wavelength,

efficiency and diameter of the emerging beam waist. Others are similar to delivery optics such as focused beam diameter, fiber diameter and focal length of the focusing lens by K. Abdel Ghany *et al,* (2004).

## 1.2 Problem statement

Composite one of the major to increase the rate of injury or accident when doing cutting activities. Generally, used the conventional method. For example hand saw,cutter machine,jigsaw and grinder. Therefore, safety for this activities of the cutting process in conventional methods is very high and should be avoided for the sake of personal safety. Although, by using the latest technology can facilitate cutting work and reduced accident rates. It is because, the laser machine has a closed door when the cutting is handled. However, in terms of cutting the material that the material can get the good surface from using conventional methods will be able to achieve the finishing not good except for skilled workforce. The quality of product is also emphasized because the quality of the conventional method is not quite accurate unless using a laser machine it can produce a more accurate product. In this problem, time also categorized as high statement because it can reduces the time on the process of cutting and will be able to analyze the parameters that need to be studied. Other than that, advantage and disadvantage also has good material for composite. Many researchers have found what material is suitable for this laser machine. The parameters for that material is important as it plays role for able to purpose and protecting that material and also improving the studied of parameter by taguchi method using composite.

## 1.3 Objective

The objectives of this research are follows;

i. To analyze the effect and accuracy of process parameters for laser cutting such as cutting speed.

ii. To identify the quality of cutting process when the product will be produced.

iii. To determine the parameter optimum of composite.

## 1.4 Scope of study

This study scope will be carried out within the following limits:

a) Fixed the thickness which is 3mm or 5mm to easy setting the laser machine.

b) Study of the parameter on the composite for a suitable factor that taken into output power.

c) Study the effect of cutting speed on the solid of composite to test the laser power and the suggested others parameter.

## 1.5 Significant of study

This study is about parameter of jet laser machine on composite by using taguchi method. Therefore, in this study is a process to facilitate work when it is known that the parameters are suitable for composites. Additionally, use in transport and furniture sections. For example; boats, planes, automotive parts, chairs, tables and others. It is important for the industry. In this study, the difference between scrap material and experiment in the lab. The strength and time are the main parameters to optimization in the laser jet machine.

# CHAPTER 2

# LITERATURE REVIEW

Previous studies that has been made by researches are called as literature review. For this chapter shows the machining of laser jet to define the parameter when use the composite. This work was carried out to optimization the parameter on composite using taguchi .The summary of this chapter will be end of the chapter.

## 2.1 Introduction of laser

Establishing the importance topic abridgment of laser is 'Light amplification by stimulated emission of Radiation Coherent, monochromatic and collimated beam of light is produced of minimum diameter of 0.002 mm. Material removals in laser beam machining by combining of melting and evaporation. JP Kaushik *et al*., (2014). Cekic *et al,* (2015) said the laser cutting technology can carry out higher processing accuracy (lower tolerance measure), better quality (less processed surface roughens, smaller heat-affected area (reduced material deformation accuracy of processing (narrower tolerance measures), better quality (less processed surface roughness), smaller width of cut (material saving), smaller heat affected zone (reduced deformation of materials), increased productivity. Therefore, to reduce the cutting price to increase the cutting speed, select the appropriate gas types or gas compounding combinations

According to Eltawahni *et al,* (2012), assisted cutting the optimum 3mm mild steel can help combination of gas. The discharge of gas is oxygen, argon, helium and nitrogen.

Then, the kerf distance of reduction rate the optical laser power will be increase and decrease. The same change with cutting speed, optical device power and gas category within the kerf breadth pressure. However, to achieve this it is necessary to optimize an oversized range of associated nonlinear joined influential parameters for every processed material and process conditions. Nowadays,the latest common laser used for the cutting are gas-discharge $CO^2$ laser with the wavelength of 10.6Um and fiber or disc lasers with the wavelength of about 1 micrometer. Scintilla *et al,* (2013).

a) b)

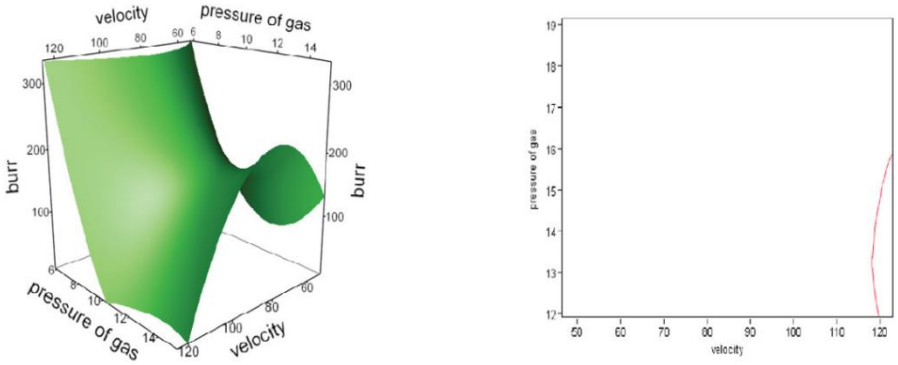


**Figure 2.1**: a)curve surface for burr response by rate and pressure of gas
b)curve line from cut of framework and surface Huehnlein *et al*, (2010)

On the basis of Figure 2.1 Huehnlein *et al,* (2010) the evidence for a quality response of the surface style is analyzed in the same way as we tend, once fiber laser is being used. Then, here we have a natural inclination to concentrate furthermore on observing the interaction between rate and level of pressure as they show the strongest correlation. Then, higher gas pressure is needed to get a faster method. Machining laser beams has the potential to engrave or cut most materials wherever common cutting

strategies may be deceptive. The laser beams can also be merged with gasses to support the cutting method to be cost effective, to minimize surface oxidation and to keep the work piece surface free of vapor or tempered material. Laser is the major source of research in the industry for the single-power unit power supply of JP Kaushik *et al,* (2014) Nethri Rammohan *et al,* (2015) Miroslav Radovanovic *et al,* (2011) was studied by many researchers using CO2 and Nd-YAG lasers.

Carbon lasers are currently available as being the most powerful wave lasers. Recent laser developments have increased the imperative for Nd-YAG lasers, but a solid optical laser has occasionally beam power but once operated on a periodic basis, high peak power changes. It is used to machine even more thick material while decoding narrow materials for a shorter pulse duration. Due to its shorter wavelength of 1 mm, Dubey and Yadava at the *et al,* (2008) can absorb high reflectivity material, which is complicated to machine using carbon dioxide lasers.

## 2.2 Type of laser machining

Laser classified: Two groups based on the lasing medium state. Rana *et al,*(2018)

### 2.2.1 Solid state lasers (Ruby,Nd-YAG)

Laser solid state could be a optical laser that uses solid as a laser medium. The primary solid state optical laser was ruby laser. Glass or crystalline materials are employed in these lasers. Material such as supp-hire (A12O3), yttrium aluminum garnet (Nd: YAG) doped with neodymium.